

CLAIMS

1. An apparatus providing an image output signal in response to an image input signal, the device comprising:
a saturation bias identification circuit having a range of useful grey-levels
5 output responsive to the image input signal; and
a cumulative distribution function scaling circuit having a scaled output responsive to the useful grey-levels output.
2. The apparatus of Claim 1 wherein the range of useful grey-levels output includes all grey-levels within a cumulative distribution function except the first
10 unsaturated grey-level within the cumulative distribution function.
3. The apparatus of Claim 1 wherein the range of useful grey-levels output includes all grey-levels within a cumulative distribution function except the last unsaturated grey-level within the cumulative distribution function.
4. The apparatus of Claim 1 wherein the range of useful grey-levels output
15 includes all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution function and the last unsaturated grey-level within the cumulative distribution function.
5. The apparatus of Claim 1 wherein the range of useful grey-levels output includes all grey-levels within a cumulative distribution function in the range from,
20 and including, the first unsaturated grey-level (k_0) plus X additional grey-levels through the last unsaturated grey-level (k_n) minus Y additional grey-levels, wherein X and Y are whole numbers greater than zero.
6. The apparatus of Claim 1 further comprising a video decoder having a digital output responsive to the image input signal, and wherein the range of useful grey-
25 levels output is responsive to the digital output of the video decoder.
7. The apparatus of Claim 1 further comprising a video encoder having an analog output responsive to the image input signal.

8. The apparatus of Claim 1 further comprising a logical device containing the saturation bias identification circuit.
9. The apparatus of Claim 8 wherein the logical device is a field programmable gate array.
- 5 10. The apparatus of Claim 1 further comprising a color transform having a luminance output signal responsive to the image input signal.
11. The apparatus of Claim 1 further comprising an image pre-contrast conditioner having a conditioned output responsive to the image input signal.
12. The apparatus of Claim 11 wherein the image pre-contrast conditioner
10 includes a median filter.
13. The apparatus of Claim 11 wherein the image pre-contrast conditioner includes a Gaussian filter.
14. The apparatus of Claim 11 wherein the image pre-contrast conditioner includes a Laplace filter.
- 15 15. The apparatus of Claim 12 wherein the image pre-contrast conditioner includes another median filter.
16. The apparatus of Claim 1 further comprising a sample area selection circuit having a selected image output signal responsive to the image input signal and an area selection input signal.
- 20 17. The apparatus of Claim 1 further comprising a histogram accumulation circuit having a histogram output responsive to the image input signal.
18. The apparatus of Claim 1 further comprising a cumulative distribution circuit having a cumulative distribution output responsive to the image input signal.
19. The apparatus of Claim 1 further comprising a lookup construction circuit
25 having a lookup table output responsive to the linear scaled output.
20. The apparatus of Claim 19 further comprising an enhanced luminance image generation circuit having an enhanced image output responsive to the lookup table and the image input signal.

21. The apparatus of Claim 1 further comprising a switch for selecting the range of useful grey-levels.
22. A method of providing an image output signal in response to an image input signal comprising the steps of:
 - 5 generating a range of useful grey-levels in response to the image input signal; and
 - generating a scaled output in response to the range of useful grey-levels.
23. The method of Claim 22 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution function.
- 10 24. The method of Claim 22 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the last unsaturated grey-level within the cumulative distribution function.
25. The method of Claim 22 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution function and the last unsaturated grey-level within the cumulative distribution function.
- 15 26. The method of Claim 22 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function in the range from, and including, the first unsaturated grey-level (k_0) plus X additional grey-levels through the last unsaturated grey-level (k_n) minus Y additional grey-levels, wherein X and Y are whole numbers greater than zero.
- 20 27. The method of Claim 22 further comprising the step of generating a digital output responsive to the image input signal.
- 25 28. The method of Claim 22 further comprising the step of generating an analog output in response to the image input signal.
29. The method of Claim 22 further comprising the step of generating a luminance output signal in response to the image input signal.

30. The method of Claim 22 further comprising the step of generating a conditioned output responsive to the image input signal.
31. The method of Claim 30 wherein the step of generating a conditioned output includes the step of applying a median filter to a pixel array.
- 5 32. The method of Claim 30 wherein the step of generating a conditioned output includes the step of applying a Gaussian filter to a pixel array.
33. The method of Claim 30 wherein the step of generating a conditioned output includes the step of applying a Laplace filter to a pixel array.
34. The method of Claim 31 further comprising the step of applying another
10 median filter to a filtered pixel array.
35. The method of Claim 31 further comprising the step of generating a selected image output signal in response to the image input signal and an area selection input signal.
36. The method of Claim 31 further comprising the step of generating a histogram
15 output in response to the image input signal.
37. The method of Claim 31 further comprising the step of generating a cumulative distribution output in response to the image input signal.
38. The method of Claim 31 further comprising the step of generating a lookup table in response to the linear scaled output.
- 20 39. The method of Claim 31 further comprising the step of generating an enhanced image output in response to the lookup table and the image input signal.
40. The method of Claim 22 further comprising the step of selecting the range of useful grey-levels.
41. A device providing an image output frame in response to an image input
25 frame, the device comprising:
a housing having a printed circuit board contained therein;
an input connector attached to the housing and having a conductive path attached to the printed circuit board;

an output connector attached to the housing and having a conductive path attached to the printed circuit board;

an integrated circuit placed on the printed circuit board, the integrated circuit having an output responsive to the image input frame, the output comprising transformed pixel frame data; and

wherein the device does not require a keyboard to operate.

42. The device of Claim 41 wherein the device is an embedded system.

43. The device of Claim 41 wherein the input connector receives thirty frames per second and the output connector provides thirty frames per second.

44. The device of Claim 41 wherein a port is not provided for operably attaching the device to the keyboard.

45. The device of Claim 41, further comprising a saturation bias identification circuit having a range of useful grey-levels output responsive to the image input frame, and a cumulative distribution function scaling circuit having a scaled output responsive to the useful grey-levels output.

46. The device of Claim 45 wherein the range of useful grey-levels output includes all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution function.

47. The device of Claim 45 wherein the range of useful grey-levels output includes all grey-levels within a cumulative distribution function except the last unsaturated grey-level within the cumulative distribution function.

48. The device of Claim 45 wherein the range of useful grey-levels output includes all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution function and the last unsaturated grey-level within the cumulative distribution function.

49. The device of Claim 45 wherein the range of useful grey-levels output includes all grey-levels within a cumulative distribution function in the range from, and including, the first unsaturated grey-level (k_0) plus X additional grey-levels

through the last unsaturated grey-level (k_n) minus Y additional grey-levels, wherein X and Y are whole numbers greater than zero.

50. The device of Claim 45 further comprising a video decoder having a digital output responsive to the image input frame, and wherein the range of useful grey-levels output is responsive to the digital output of the video decoder.

51. The device of Claim 45 further comprising a video encoder having an analog output responsive to the image input frame.

52. The device of Claim 45 further comprising a logical device containing the saturation bias identification circuit.

10 53. The device of Claim 52 wherein the logical device is a field programmable gate array.

54. The device of Claim 45 further comprising a color transform having a luminance output frame responsive to the image input frame.

15 55. The device of Claim 45 further comprising an image pre-contrast conditioner having a conditioned output responsive to the image input frame.

56. The device of Claim 55 wherein the image pre-contrast conditioner includes a median filter.

57. The device of Claim 55 wherein the image pre-contrast conditioner includes a Gaussian filter.

20 58. The device of Claim 55 wherein the image pre-contrast conditioner includes a Laplace filter.

59. The device of Claim 56 wherein the image pre-contrast conditioner includes another median filter.

25 60. The device of Claim 45 further comprising a sample area selection circuit having a selected image output frame responsive to the image input frame and an area selection input frame.

61. The device of Claim 45 further comprising a histogram accumulation circuit having a histogram output responsive to the image input frame.

62. The device of Claim 45 further comprising a cumulative distribution circuit having a cumulative distribution output responsive to the image input frame.

63. The device of Claim 45 further comprising a lookup construction circuit having a lookup table output responsive to the linear scaled output.

5 64. The device of Claim 63 further comprising an enhanced luminance image generation circuit having an enhanced image output responsive to the lookup table and the image input frame.

65. The device of Claim 45 wherein the range of useful-grey levels is responsive to a switch position.

10 66. A method for providing an image output frame in response to an image input frame, the method comprising the steps of:

segmenting the image input frame into one or more zones;

determining a plurality of grey-level values for a pixel based, at least in part, on grey-level data contained within the one or more zones; and,

15 calculating a composite enhanced pixel grey-level value for the pixel by blending the plurality of grey-level values.

67. The method of Claim 66 wherein the image input frame is segmented into a plurality of zones.

20 68. The method of Claim 66 further comprising establishing reference points within the image input frame, and wherein the step of calculating a composite enhanced pixel grey-level value is based, at least in part, on distance from the reference points.

25 69. The method of Claim 67 further comprising generating a range of useful grey-levels for each zone, and generating a scaled output in response to at least one of the ranges of useful grey-levels.

70. The method of Claim 69 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution function.

71. The method of Claim 69 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the last unsaturated grey-level within the cumulative distribution function.
72. The method of Claim 69 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution function and the last unsaturated grey-level within the cumulative distribution function.
73. The method of Claim 69 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function in the range from, and including, the first unsaturated grey-level (k_0) plus X additional grey-levels through the last unsaturated grey-level (k_n) minus Y additional grey-levels, wherein X and Y are whole numbers greater than zero.
74. The method of Claim 66 further comprising the step of generating a digital output responsive to the image input frame.
75. The method of Claim 66 further comprising the step of generating an analog output in response to the image input frame.
76. The method of Claim 66 further comprising the step of generating a luminance output signal in response to the image input frame.
77. The method of Claim 66 further comprising the step of generating a conditioned output responsive to the image input frame.
78. The method of Claim 77 wherein the step of generating a conditioned output includes the step of applying a median filter to a pixel array.
79. The method of Claim 77 wherein the step of generating a conditioned output includes the step of applying a Gaussian filter to a pixel array.
80. The method of Claim 77 wherein the step of generating a conditioned output includes the step of applying a Laplace filter to a pixel array.
81. The method of Claim 78 further comprising the step of applying another median filter to a filtered pixel array.

82. The method of Claim 66 further comprising the step of generating a selected image output signal in response to the image input frame and an area selection input signal.
- 5 83. The method of Claim 66 further comprising the step of generating a histogram output in response to the image input frame.
84. The method of Claim 66 further comprising the step of generating a cumulative distribution output in response to the image input frame.
85. The method of Claim 69 further comprising the step of generating a lookup table in response to the scaled output.
- 10 86. The method of Claim 85 further comprising the step of generating an enhanced image output in response to the lookup table and the image input signal.
87. The method of Claim 66 further comprising the step of segmenting the image input frame into four zones with each zone comprising a mutually exclusive quadrant of the image input frame.
- 15 88. A method for providing an image output frame in response to an image input frame, the method comprising the steps of:
- establishing reference points within the image input frame;
 - calculating grey-level values for a plurality of pixels within the image input frame; and,
 - 20 calculating a composite enhanced pixel grey-level value for the pixels based, at least in part, on distance from the reference points.
89. The method of Claim 88 further comprising segmenting the image input frame into a plurality of zones, and wherein at least one of the reference points is located within one of the zones.
- 25 90. The method of Claim 88 further comprising generating a range of useful grey-levels in response to the image input frame, and generating a scaled output in response to the range of useful grey-levels.

91. The method of Claim 90 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution function.
92. The method of Claim 90 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the last unsaturated grey-level within the cumulative distribution function.
93. The method of Claim 90 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution function and the last unsaturated grey-level within the cumulative distribution function.
94. The method of Claim 90 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function in the range from, and including, the first unsaturated grey-level (k_0) plus X additional grey-levels through the last unsaturated grey-level (k_n) minus Y additional grey-levels, wherein X and Y are whole numbers greater than zero.
95. The method of Claim 88 further comprising the step of generating a digital output responsive to the image input frame.
96. The method of Claim 88 further comprising the step of generating an analog output in response to the image input frame.
97. The method of Claim 88 further comprising the step of generating a luminance output signal in response to the image input frame.
98. The method of Claim 88 further comprising the step of generating a conditioned output responsive to the image input frame.
99. The method of Claim 98 wherein the step of generating a conditioned output includes the step of applying a median filter to a pixel array.
100. The method of Claim 98 wherein the step of generating a conditioned output includes the step of applying a Gaussian filter to a pixel array.

101. The method of Claim 98 wherein the step of generating a conditioned output includes the step of applying a Laplace filter to a pixel array.
102. The method of Claim 99 further comprising the step of applying another median filter to a filtered pixel array.
- 5 103. The method of Claim 99 further comprising the step of generating a selected image output signal in response to the image input frame and an area selection input signal.
104. The method of Claim 99 further comprising the step of generating a histogram output in response to the image input frame.
- 10 105. The method of Claim 99 further comprising the step of generating a cumulative distribution output in response to the image input frame.
106. The method of Claim 88 further comprising the step of segmenting the image input frame into four zones with each zone comprising a mutually exclusive quadrant of the image input frame.
- 15 107. A method for providing an image output frame in response to an image input frame, the method comprising the steps of:
- constructing an equalized lookup table for the image input frame;
- constructing an equalized lookup table for a zone within the image input frame; and,
- 20 utilizing the lookup tables to build a balanced lookup table.
108. The method of Claim 107 further comprising the step of utilizing a lookup table representative of the image input frame to build the balanced lookup table.
109. The method of Claim 108 wherein the lookup table representative of the image input frame is an identity lookup table.
- 25 110. The method of Claim 107 further comprising the step of segmenting the image input frame into a plurality of zones.

111. The method of Claim 110 further comprising establishing reference points within at least two of the zones, and calculating a composite enhanced pixel grey-level value based, at least in part, on distance from the reference points.

5 112. The method of Claim 107 wherein the step of constructing an equalized lookup table for a zone includes generating a range of useful grey-levels within the zone, and generating a scaled output in response to the range of useful grey-levels.

113. The method of Claim 112 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution
10 function.

114. The method of Claim 112 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the last unsaturated grey-level within the cumulative distribution function.

15 115. The method of Claim 112 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function except the first unsaturated grey-level within the cumulative distribution function and the last unsaturated grey-level within the cumulative distribution function.

20 116. The method of Claim 112 wherein the step of generating a range of useful grey-levels includes specifying all grey-levels within a cumulative distribution function in the range from, and including, the first unsaturated grey-level (k_0) plus X additional grey-levels through the last unsaturated grey-level (k_n) minus Y additional grey-levels, wherein X and Y are whole numbers greater than zero.

25 117. The method of Claim 112 further comprising the step of generating a digital output responsive to the image input frame.

118. The method of Claim 107 further comprising the step of generating an analog output in response to the image input frame.

119. The method of Claim 107 further comprising the step of generating a luminance output signal in response to the image input frame.

120. The method of Claim 107 further comprising the step of generating a conditioned output responsive to the image input frame.

5 121. The method of Claim 120 wherein the step of generating a conditioned output includes the step of applying a median filter to a pixel array.

122. The method of Claim 120 wherein the step of generating a conditioned output includes the step of applying a Gaussian filter to a pixel array.

10 123. The method of Claim 120 wherein the step of generating a conditioned output includes the step of applying a Laplace filter to a pixel array.

124. The method of Claim 107 further comprising the step of segmenting the image input frame into four zones with each of said zones comprising a mutually exclusive quadrant of the image input frame.

15 125. An apparatus providing an output of signal values in response to an input of signal values derived directly or indirectly from a sensor, wherein each input value is variable within a range of values based upon an environment sensed by the sensor, and each value of the input signal has a spatial and or geometric relationship to other values in the input signal, the device comprising:

20 a signal intensity over limit or saturation identification circuit having a range of useful signal intensities output responsive to the image input signal; and

a cumulative distribution function scaling circuit having a scaled output responsive to useful signal intensity output.

25 126. A method of providing an output of signal values in response to an input of signal values derived directly or indirectly from a sensor, wherein each input value is variable within a range of values based upon an environment sensed by the sensor, and each value of the input signal has a spatial and or geometric relationship to other values in the input signal, comprising the steps of:

generating a range of useful signal intensities in response to the image input signal; and

generating a scaled output in response to the range of useful signal intensities.

127. A method for providing an output of signal values in response to an input
5 array of signal values derived directly or indirectly from a sensor, wherein each input value is variable within a range of values based upon an environment sensed by the sensor, and each value of the input signal has coordinates with a spatial and or geometric relationship to other values in the input signal, comprising the steps of:
- segmenting the image input array into one or more spatial zones;
- 10 determining a plurality of signal intensity values for a coordinate based, at least in part, on signal intensity contained at coordinates within the one or more other zones; and,
- calculating a composite enhanced coordinate signal value for the coordinate by blending the plurality of signal intensity values.
- 15 128. A method for providing an output of signal values in response to an input array of signal values derived directly or indirectly from a sensor, wherein each input value is variable within a range of values based upon an environment sensed by the sensor, and each value of the input signal has coordinates with a spatial and or geometric relationship to other values in the input signal, comprising the steps of:
- 20 establishing reference points within the array of signal values;
- calculating signal intensity values for a plurality of coordinates within the array of input values; and,
- calculating a composite enhanced coordinate signal intensity value for the coordinates based, at least in part, on a distance of the coordinate from the reference
25 points.
129. A method providing an output of signal values in response to an input array of signal values derived directly or indirectly from a sensor, wherein each input value is variable within a range of values based upon an environment sensed by the sensor,

and each value of the input signal has coordinates with a spatial and or geometric relationship to other values in the input signal, comprising the steps of:

constructing an equalized lookup table for the array of signal intensity values;

constructing an equalized lookup table for a zone within the array of signal

5 intensity values; and,

utilizing the lookup tables to build a balanced lookup table.